USSR Report

EARTH SCIENCES

No. 8

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PHYSICS OF ATMOSPHERE

METEOROLOGY

TRANSVERSE DIFFUSION IN ATMOSPHERIC SURFACE LAYER

[Article by Ye. K. Garger, A. V. Naydenov ar I D. B. Uvarov, Institute of
Experimental Meteorology, "Transverse Diffusion in the Atmospheric Surface
Layer"]

[Abstract] The authors report on an experimental study of the relative
transverse dispersion of the coordinates of particles S_y in smoke plumes
in the atmospheric surface layer in the case of neutral and unstable strat-
ifications. These experiments were made for the purpose of checking the
applicability of the Lagrangian turbulence similarity hypothesis in the at-
mospheric surface layer for the transverse dispersion of coordinates and
evaluating the possibility of their use for a broad range of atmospheric
conditions. It is shown that an increase in S_y with diffusion time confirms
the limiting regime $S_y^2(t) = \beta_y u*^2 t^2$, predicted by the Langrangian turbul-
ence similarity theory. The experimental data are used in determining the
β_y constant. Figures 5, tables 1; references: 9 Russian.
[321-5303]

OCEANOGRAPHY

LAWS FOR EXPLOSIVE ACOUSTIC WAVES IN OCEAN

[Article by V. Ye. Fridman, Gor'kiy Scientific Research Radiophysics Institute, "Comparison of Empirical and Theoretical Laws for Explosive Acoustic Waves in Ocean"]

[Abstract] The author gives a comparison of empirical and theoretical relationships in nonlinear geometrical acoustics for the parameters of powerful acoustic waves in the ocean generated by an explosive source. There was found to be a good agreement of the relationships for the amplitude of the disturbance of pressure and energy of the explosive exponential wave in the entire range of distances and weight of charges characteristic for the numerous experiments. The comparison made it possible to determine the interrelationship of the parameters entering into the theoretical expressions and the weight of the charge, and in the computations this makes it possible to take into account the joint influence of signal nonlinearity and nonuniformity of the oceanic medium. Figures 3; references 15: 5 Russian, 10 Western.
[321-5303]

METHOD FOR OPTIMUM CALIBRATION OF REMOTE INSTRUMENTS

[Article by S. V. Dotsenko and L. G. Salivon, Marine Hydrophysical Institute, "Optimum Calibration of Remote Instruments Using Results of Direct Measurements in Ocean"]

[Abstract] The authors present a review of methods for optimum averaging of signals from direct measurement contact instruments intended for calibration of remote instruments and evaluate the calibration errors which arise

in these procedures. There are three possible methods for such averaging: spatial, spatial-temporal and temporal, but the first two have serious drawbacks and the article therefore deals with temporal averaging of the signal of a contact instrument. This requires use of only one instrument. An optimum method is found for such averaging. It ensures the best calibration accuracy. It is assumed that the measured field is centered, uniform, isotropic and not "frozen-in." It is further assumed that the instruments for both direct and remote measurements are inertialess. The authors define their scheme for obtaining the standard field value by a direct measurement instrument. The simplest method for calibration of a remote instrument is shown to be calibration on the basis of one instantaneous reading of a point contact measurement instrument. Using a single point reading .t is possible to calibrate instruments the radius of whose resolution element is small in comparison with the characteristic scale of the measured field. The optimum calibration procedure involves time averaging. Optimum calibration is the more effective the greater is the radius of a resolution element of the remote instrument in comparison with the characteristic field scale. Calibration is most desirable using "frozen-in" fields, that is, fields which experience slight evolution with time. The optimum processing of signals at the output of direct measurement instruments considerably increases the accuracy in calibrating remote instruments. Figures 3; references: 9 Russian.

[301-5303]

STRUCTURE AND DESCRIPTION OF ACOUSTIC OCEANOLOGICAL MODELS

[Article by N. A. Grubnik and V. V. Ol'shevskiy, Acoustics Institute USSR Academy of Sciences and Computation Center Tadzhik Academy of Sciences, "Acoustic-Oceanological Models (Structure and Description)"]

[Abstract] Long-term investigations of acoustic phenomena in the ocean and in the field of oceanology have made it possible to proceed to formulate quite sound acoustic-oceanological models. This article is a further development of articles published earlier by the authors (TRUDY PERVOGO SEMINARA: AKUSTICHESKIYE STATISTICHESKIYE MODELI OKEANA, Moscow, 3-11, 1977; TRUDY IV NAUCHNO-TEKHNICHESKOY KONFERENTSII PO INFORMATSIONNOY AKUSTIKE, Moscow, 3-12, 1978). There are at least two principal reasons for formulating such models: creation of a theory, methods and means for investigating the ocean by acoustic methods and analysis and synthesis of information on hydroacoustic systems for underwater observation and communication. The main purpose of an acoustic-oceanological model is for predicting different phenomena in the ocean. Such a model should be formulated on theoretical-probabilistic principles. Such models are based on probability theory

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and mathematical statistics due to: the great number of phenomena in the
ocean, definite monitoring and prediction of which are virtually impos-
sible; poor factual study of most oceanological and acoustic phenomena.
Acoustic-oceanological models are fundamentally multidimensional, making it
necessary to use the methods of multidimensional statistical analysis and
image recognition, cluster analysis, etc. The structure of such acoustic-
oceanological models and the methods for their description are discussed.
Figures 1; references 15: 12 Russian, 3 Western.
[325-5303]

COMPUTER PROCESSING OF GRAVITY MEASUREMENTS

[Article by P. A. Neberov and Z. P. Tarapova, "Computer Processing of Grav-
ity Measurements on Unified System Electronic Computers"]

[Abstract] Specialists at the Central Scientific Research Institute of Geod-
esy, Aerial Mapping and Cartography have developed a complex of programs in
FORTRAN language for unified system electronic computers for the automated
office processing of sea gravimetric surveys carried out by the combined
method (pendulum instruments and gravimeters). The basic and auxiliary pro-
grams are formulated on the basis of the modular principle and based on
formulas transformed to a form convenient for taking into account instru-
mental corrections and external influences, including the gravity field
gradient. The programs provide for carrying out operations for computing
gravity, determined by a group of instruments (not more than six), evalua-
tion of the accuracy of survey results, adjustment of areal surveys and
preparation of a catalogue in a form convenient for storage on modern carr-
iers at centers for the collection, storage and exchange of gravimetric
data. The work area is divided into sectors. A sector takes in a system
of runs along which continuous gravity measurements were made at not more
than 1,000 points. The entire mass of data is processed successively by
sectors. The different corrections are introduced (for example, for the
lag of gravimeter readings, Eötvös correction). The numerical data are
punched on punch cards by groups of data in the following sequence: 1)
name of ship, year of determinations; 2) gravity at the initial point and
its mean square error, number of gravimeters; 3) time of gravimeter read-
ings at initial point, shift of gravimeter null point, time constant of
elastic system; name of sector, number of control coordinate points, meas-
urement interval, height of instrument over sea level and its mean square
error, density of intermediate layer, number of first point in sector, num-
ber of first run in sector, measurement time at first point in sector, meas-
urement time at last point in sector; 5) coordinates of control points and
mean square errors of their determination; 6) sea depth and mean square
error in its determination; 7) gravimeter readings at determined points.

The final result of automated processing of sea gravimetric measurements
is a catalogue of points and punched cards for storing data at data col-
lection centers.
[315-5303]

HYDROGRAPHIC ECHOTRAWL FOR SMALL BOAT

[Article by V. V. Starozhitskiy, "GET-2 Hydrographic Echotrawl for Small
Boat"]

[Abstract] The GET-2 echotrawl (a sketch accompanies the text) is a multi-
vibrator hydroacoustic system which is used in measuring depths, in de-
tecting underwater navigational hazards and in searching for sunken ob-
jects in ports, harbors and channels. The echotrawl consists of two (left
and right) extensions, a central instrument, two sources-detectors and two
cable boxes. The span of the echotrawl is determined by the regulable
length of the extension arms and these are maintained above the water by
floats. These arms carry vibrators, up to nine on each side. The bottom
profile under the boat is "inspected" by vibrators on the boat's bottom --
as many as ten. The total number of vibrators must not exceed 24. The dis-
tance between adjacent vibrators is 1 m. The echotrawl can measure depths
and register bottom profiles in 24 channels simultaneously (12 on each
side). The channel was constructed on the principle of an echo sounder
with a vertical acoustic ray. The working frequencies of the channels on
the right and left sides are different. There is a generator and amplifier
for each four channels. The apparatus can register such underwater objects
as sunken ships or their fragments, metal barrels, individual rocks, sunk-
en buoys, logs and piles. The "resolution" of the echotrawl is such that
it reliably detects objects on the bottom having vertical dimensions not
less than 0.3 and 0.6   in the subranges 0-12.5 and 0-25 m respectively.
Depths from 2 to 25 m can be registered. The GET-2 echotrawl has cable
communication with an automated hydrographic radio rangefinding system
which makes it possible to ascertain the position of the boat on its run
with a high accuracy. Figures 1.
[315-5303]

FIELD OF SYNOPTIC EDDIES IN OPEN OCEAN

[Article by M. N. Koshlyakov, Yu. M. Grachev and V. Yenikeyev, Institute of Oceanology, "Kinematics of the Field of Synoptic Eddies in the Open Ocean"]

[Abstract] The article continues the analysis of the results of measurements of ocean currents by the Soviet POLIMODE buoy system in the Sargasso Sea in 1977-1978. In this research area the barotropic and baroclinic velocity components were developed approximately to an identical degree. Maps of synoptic currents were constructed (examples are shown as Figures 1 and 2). The current maps, plotted for different horizons and dates, indicated that during the observation period more than 10 well-expressed cyclonic and anticyclonic eddies passed through the POLIMODE region in a westward direction. There is clearly a predominance of the Rossby scale in the horizontal distribution of eddy energy, which agrees with the theory of R. B. Rhines, who regards baroclinic eddies in the open ocean to be a result of interaction between Rossby waves and large-scale geostrophic turbulence. One of the most interesting effects was the periodic appearance in the baroclinic layer (to a depth of 1,000-1,200 m) of strong isolated eddies and streams separated by regions of very weak currents. It appears that there is interaction between nonlinear effects and the dispersion of Rossby waves, scattered by strong eddies, with alternate local predominance of first one and then the other effect. The total period of restructuring of the velocity field, associated with the mentioned interaction, was 1 1/2-2 months, a value of the same order of magnitude as the period of local velocity fluctuations caused by the westward drift of eddies. In general, the results of POLIMODE agree with the theoretical concepts of F. P. Bretherton, et al. who regard synoptic eddies in the ocean to be some complex synthesis of Rossby waves and geostrophic turbulence. However, the effect of barotropization of strong eddies with a further increase in their size and the appearance of primarily zonal currents in the ocean was not observed. Figures 3, tables 1; references 7: 4 Russian, 3 Western.
[343-5303]

TERRESTRIAL GEOPHYSICS

CHANGES IN GRAVITY FIELD ACCOMPANYING VERTICAL SHIFTS OF EARTH'S SURFACE

[Article by S. M. Molodenskiy, Institute of Physics of the Earth, "Change in Gravity Field Accompanying Vertical Displacements of Earth's Surface"]

[Abstract] A study was made of elastic deformations of a real model of the earth excited by stresses of a general type. An arbitrary source of stresses is represented in the form of the sum of potential and eddy force fields. The case of a potential source corresponds to a focus causing hydrostatic compressional stresses and the case of an eddy source corresponds to shearing stresses. A solution of the problem is presented in the form of expansions in spherical coordinates. It is shown that for a hydrostatic compressional source situated at a depth of less than 2,000 km the ratio of the change in acceleration of gravity to the change in height at this same point in a general case is close to the gradient of acceleration of gravity in the free air. In the case of a shearing stresses source the ratio of the coefficients of expansion of gravity changes to the coefficients of expansion of changes in heights relative to the level surface is expressed through the ratio of the Love and Sheed numbers to the load coefficients. The article gives the results of numerical computations of aspherical thermoelastic deformations of the earth, taking into account self-gravitation, radial inhomogeneity of the earth's structure and the presence of a liquid core. Tables 3; references 9: 6 Russian, 3 Western.
[322-5303]

THEORY OF DIRECTED SEISMIC ANTENNAS

[Article by V. A. Babeshko and Zh. F. Zinchenko, Scientific Research Institute of Mechanics and Applied Mathematics at Rostov State University, "Theory of Directed Seismic Antennas"]

[Abstract] The authors formulate and investigate the problem of creating wave fields with a particular directional diagram by stamps vibrating on the surface of an elastic half-space. In contrast to light or acoustic waves, which in an unbounded homogeneous medium can be imparted the necessary direction by reflectors or horns, in the case of seismic waves the problem is complicated by the presence of a boundary at which the source is situated. It is demonstrated theoretically in this paper that there are forms of oscillation of a flexible stamp on the surface of a homogeneous isotropic half-space ensuring a stipulated direction of the main lobe of the directional diagram of longitudinal or transverse waves. Seismic antennas could be useful in the probing of underground objects or investigating the earth's deep structure. References: 3 Russian.
[318-5303]

MECHANISM OF HYDROGEODYNAMIC EARTHQUAKE PRECURSOR

[Article by F. I. Monakhov, Sakhalin Multidiscipline Scientific Research Institute, "Mechanism of Formation of Hydrogeodynamic Earthquake Precursor"]

[Abstract] It has been postulated that all earthquake precursors observed at the earth's surface are formed in the focal region of an impending tremor and are related to the formation of fractures and other structural changes in rocks in this region. Such a concept explains well the possibility of the appearance of different precursory effects if the observations are made in or near the fracturing region. But in most cases the precursors are registered far beyond the limits of the focal region and the mechanism of their formation remains unclear. Long-term continuous registry of fluctuations of water level in boreholes in the Kurile Islands and on Sakhalin and surface deformations on Shikotan Island have made it possible to study the properties of a hydrogeodynamic precursor and on this basis understand the mechanism of its formation. A hydrogeodynamic precursor appears precisely one or two days in advance simultaneously at points from several kilometers to several hundred kilometers distant from

the focus. The reaction of ground water to earthquake preparation always begins with a decrease in level four to ten days prior to a tremor, regardless of the location, mechanism and depth of the focus. In most cases when hydrogeodynamic precursors have been registered there was a change in the rate and sign of deformation of the earth's surface on Shikotan. As a rule, a decrease in water level corresponded to dilatation and a level rise is accompanied by deformation. As a result of dilatation there is an opening of pores and fissures in the crustal surface layer, and this should invariably lead to a decrease in the ground water level; compression results in a closing of pores and fissures and accordingly a rise in water level. It was established that this is very important for understanding the mechanism of formation of a hydrogeodynamic precursor, that the change in the ground water regime before a tremor began precisely one or two days before the event and the change in the deformation curve for different distances between the focus and the observation points. The determined properties of a hydrogeodynamic precursor cannot be explained from the point of view of existing concepts concerning the formation of precursors in the earthquake focus region. In actuality, due to the exceedingly low rate of ground water diffusion a drop in water level due to its outflow toward the focal region should occur at a considerably different time in boreholes at different distances and in most cases considerably after the time of the earthquake. It can only be concluded that the change in the regime of ground water before earthquakes is a result of deformation of the earth's surface at the observation point. Figures 2, tables 2; references 7: 4 Russian, 3 Western.

[319-5303]

SALT OVERHANGS ON DOMES IN CASPIAN BASIN

[Article by G. Ye.-A. Ayzenshtadt, M. V. Gorfunkel', G. I. Lamber, M. F. Serebryakov and V. P. Sheptunov, "Salt Overhangs on Domes in Caspian Basin"]

[Abstract] The cores of salt domes have a complex and diverse configuration. Along their peripheries there are salt overhangs with which petroleum deposits are sometimes associated. In particular, petroleum has been produced from beneath such overhangs in Germany and the United States. In the USSR, in the Caspian basin, a limited number of such structures have been explored. The article describes two such cases of overhangs and accompanying structures: the Vostochnyy Zhanatalap (Fig. 1) and Dossor (Fig. 2) overhang complexes. The authors assess the great difficulties involved in studying such structures by different seismic and gravimetric methods, none of which are proving very effective. The article discusses

different theories of how salt overhangs are formed: partial dissolving
of the walls of salt stocks under the influence of ground water, salt
lakes hypothesis, hypothesis of modification of salt stocks in the course
of their development, hypothesis of outpouring of salt onto the earth's
surface with its subsequent burial under deposits. The formations asso-
ciated with overhangs can be the object of a new direction in exploration
for petroleum and gas. Due to the complex geological structure of the
formations beneath overhangs there are great difficulties involved which
require additional research in a number of areas. In particular, there is
a need for a more detailed study of the stratigraphy of Lower Triassic
and Upper Permian deposits in the Caspian basin with which overhangs are
associated and improvement of the method for geophysical study of steeply
dipping horizons associated with these formations. Figures 2; references
10; 7 Russian, 3 Western.
[331-5303]

SINGULARITIES METHOD IN INTERPRETATION OF MAGNETIC ANOMALIES

[Article by G. M. Voskoboynikov and N. I. Nachapkin, "Theoretical Premises
and Experience in Application of the Singularities Method to the Interpret-
ation of Complex Magnetic Anomalies"]

[Abstract] After publication of the first variant of the singularities
method (G. M. Voskoboynikov, IZV. AN SSSR, FIZIKA ZEMLI, No 5, 1969) there
has been accumulation of considerable experience in its application to in-
terpretation of field data. A number of shortcomings of the method were
discovered and an interpretation method was developed which has completely
or partially eliminated these shortcomings and increased the effectiveness
of the method. The authors therefore deem it desirable to reexamine (from
a qualitative point of view) the theoretical principles of this method,
devoting special attention to details of practical importance and illus-
trating the interpretation method in typical theoretical and practical
examples. The singularities method is intended for the interpretation of
potential, for the most part gravitational and magnetic fields, but exper-
ience in its application has been accumulated applicable only to interpret-
ation of magnetic anomalies. The principal merit of the singularities meth-
od is a virtually complete nondependence of the interpretation results ob-
tained using it on the regional background against which the investigated
anomaly is observed. By "regional background" is meant any field whose
singularities are at depths substantially exceeding the depth of the in-
vestigated source or at the corresponding distances from the anomaly epi-
center in the horizontal plane. Precisely this property makes the method
especially suitable for interpreting complex anomalies. Figures 8, tables
2; references: 6 Russian.
[279-5303]

COMPUTATION OF MAGNETIC FIELD OF POINT SOURCE

[Article by Yu. M. Gurevich, V. V. Kormil'tsev and V. D. Semenov, "Computa-
tion of the Magnetic Field of a Point Source of a d-c Current for Axially
Symmetric Problems"]

[Abstract] If the stationary distribution of current density in the entire
space V is known, the magnetic field H in principle can be found from the
Biot-Savart formula

$$H = \int_V \frac{[\bar{j} \cdot \bar{R}]}{R^3}\, dV,$$

where $\bar{R}$ is the radius-vector of a current element $\bar{j}dV$ relative to the ob-
servation point. However, the direct use of this formula for numerical
computations is time-consuming even for modern computers. Accordingly,
the authors have endeavored to obtain other forms of solution, particular-
ly analytical, facilitating computations and making possible direct anal-
ysis of the result. The article gives a solution for axially symmetric
fields leading extremely simply to a result in analytical form. In addi-
tion to describing the method, the paper gives earlier unknown solutions,
obtained on its basis, which are of methodological interest for geophysics.
The following cases are considered: sphere of the radius a in the field
of a point source of current situated at the distance d from its center;
compressed and flattened spheroid in the field of a point source of cur-
rent situated on the axis of rotation; unbounded stratum of the thickness
2δ in the field of a point source of current situated in the mean plane
of a stratum; point source of a current in a homogeneous anisotropic medi-
um. The solutions presented in the paper together cover computation of
magnetic fields in most of the main problems in electric prospecting ex-
amined by A. I. Zaborovskiy in ELEKTRORAZVEDKA (Electric Prospecting)
(Moscow, Gostoptekhizdat, 1963). The materials in this article constitute
a supplement to that monograph. References: 3 Russian.
[279-5303]

FREQUENCY AND GEOMETRIC INDUCTION SOUNDING OF LAYERED MEDIA

[Article by R. B. Zhuravleva and V. S. Titlinov, "Frequency and Geometric Induction Sounding of Layered Media Using an Apparatus With Vertically Spaced Sensors"]

[Abstract] Electromagnetic sounding for study of layered structures and local electric inhomogeneities is accomplished using an apparatus with source and detector spaced along the earth's surface. One of the shortcomings of this sounding method is the difficulty in spatial tie-in of the measurement results, uncertainty of the registry point. In sounding with source and detector spaced along the surface the apparatus can intersect vertical contacts or other surface inhomogeneities. The so-called side effects which arise distort the measurement results and with an increase in the desired depth of research and a relative decrease in the useful signals because of these side effects it is impossible to obtain information concerning the studied object. Accordingly, the authors examine an apparatus with horizontal detection and generating loops spaced vertical-ly instead of horizontally. The vertical axially centered positioning of the sensors ensures an unambiguity in the tie-in of the recording point in the terrain. Since neither the source nor detector intersect vertical boundaries (or intersect them simultaneously), it is possible to expect averaging and attenuation of side effects. The article analyzes the prob-lem of the field of a magnetic dipole raised somewhat above a layered medium, gives a theoretical examination of the possibilities of sounding with such an apparatus and presents the results of modeling, confirming the preferability of a vertical apparatus for attenuating side effects in comparison with the traditional apparatus used in induction soundings. Figures 8; references: 3 Russian.
[279-5303]

ALGORITHM FOR INVERSE PROBLEM IN MAGNETOTELLURIC SOUNDING

[Article by O. A. Khachay, "One Algorithm for Solving the Inverse Problem in Deep Magnetotelluric Sounding"]

[Abstract] An approximate method is proposed for solving the inverse prob-lem in deep magnetotelluric sounding using impedance and phase modulus val-ues. The problem is formulated as follows. The geoelectric section of a

horizontally layered medium with a constant resistivity in each layer is
stipulated and the following physical picture is examined. It is assumed
that the medium consists of layers with resistivities ρ_n and thicknesses
h_n. Proceeding on the basis of physical concepts concerning the propaga-
tion of an electromagnetic field in a conducting medium, it is always pos-
sible to select such a high frequency ω_1 at which the input impedance of
an n-layered medium $Z_n(\omega_1)$ will be determined only by the resistance ρ_1
of the upper conducting layer. It can be approximated by the input imped-
ance of an equivalent half-space $Z_1(\omega_1)$, from which it is possible to de-
termine the resistance of the first layer. With a decrease in frequency
the electromagnetic field penetrates into the lower-lying layers and their
influence begins to be reflected on the input impedance of the n-layered
medium. The frequency is reduced to $\omega_2 = \omega_1 - \Delta\omega$. The input impedance
$Z_n(\omega_2)$ at the frequency ω_2 is approximated by the input impedance of a
two-layered medium with the parameters ρ_1, h_1, ρ_2. The parameters h_1 and
ρ_2 are determined from the condition that at the depth h_1 the input im-
pedance $Z_{n-1}(\omega_2)$ of an (n - 1)-layered medium can be approximated by the
input impedance of an equivalent half-space with the resistance ρ_2. This
procedure is repeated until the impedance frequency curve is exhausted.
It is shown that the proposed qualitative examination, based on the depend-
ence of the depth of penetration of a plane electromagnetic wave on fre-
quency, makes it possible to obtain a new method for the interpretation
of magnetotelluric data. The algorithm for solution of these problems is
given in detail. Application of the algorithm is presented in examples.
Figures 6; references 5: 4 Russian, 1 Western.
[279-5303]

CONCENTRATION CRITERION FOR SEISMOGENIC DISLOCATIONS

[Article by G. A. Sobolev and A. D. Zav'yalov, Institute of Physics of the
Earth, "Concentration Criterion for Seismogenic Dislocations"]

[Abstract] The final destruction of solid bodies, associated with the prop-
agation of a main fracture, is preceded by the stage of volumetric destruc-
tion of the material -- the accumulation of microfractures and their subse-
quent enlargement and merging. The "concentration criterion" is the decis-
ive factor in transition from micro- to macrodestruction

$$K = N_*^{-1/3} / \bar{l},$$

where N_* is the number of fractures incipient in a unit volume in a predis-
rupted state, $\bar{l}$ is the mean dimension of the incipient fractures. Rupturing,
loss of stability and breakdown of the loaded body into parts occurs when
the concentration of incipient fractures in some volume of the solid body
attains a critical value. The mean value of the concentration criterion in

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the destruction of samples of different materials, including minerals and rocks, is $K = 3-5$ with a broad variation of both the magnitude of the incipient fractures and their number. In this paper the authors attempt to estimate the value of the concentration criterion for the seismically active zone of Kamchatka before strong earthquakes. The study is based on data from a regional catalogue of earthquakes on Kamchatka and in the Komandorskiye Islands for the period 1963-1978. The catalogue includes about 28,000 seismic events. The computations were made for earthquakes in energy classes $K_{s1,2}^{[98]} > 8.5$ with hypocentral depths $H \leqslant 100$ km. In order to construct maps of values of the concentration criterion for seismogenic faults K_{sf} the considered seismically active zone was broken down into overlapping elementary volumes, in each of which the K_{sf} values were reckoned for some time interval T, beginning with the time T_0. K_{sf} maps were prepared for the following elementary volumes: 200 x 200 x 100 km, 100 x 100 x 100 km and 50 x 50 x 50 km for the period from 1963 to 1978; the interval of increase in the time interval was $\Delta T = 0.5$ year. A study of a series of K_{sf} maps at different spatial-scale levels indicated that in the regions of epicenters of future earthquakes or their groups there is development of zones of reduced K_{sf} values appearing 4.5 ± 3 years prior to the corresponding seismic events. The concentration criterion for destruction of solid bodies can be used in earthquake prediction. Figures 2; references: 7 Russian.
[340-5303]

GROUPING OF EARTHQUAKES IN TADZHIKISTAN

[Article by K. M. Mirzoyev, Institute of Seismic-Resistant Construction and Seismology Tadzhik Academy of Sciences, "Grouping of Earthquakes in Tadzhikistan"]

[Abstract] There are groups of earthquakes having an approximately identical energy; these are called swarms. Existing methods for grouping earthquakes have been inadequate. In order to simplify the method for discriminating groups of earthquakes and precluding elements of subjectivity the author has developed a method and prepared an algorithm and program for the grouping of earthquakes. The method is based on the principle of non-correspondence of the distribution of a series of earthquakes in space and time to a random Poisson distribution. The investigation was made over the territory of Tadzhikistan and adjacent regions with the coordinates $36-40°N$ and $67-75°E$; the area was $S \approx 310,000$ km^2. The number of crustal earthquakes registered in this area from 1955 to 1974 with the energy classes $K \geqslant 10$ is 4,766. Only earthquake with foci to 60 km were considered. The mean time of occurrence of earthquakes over the entire area with $K \geqslant 10$

is $\Delta t = 20$ years/4766 = 37 hours; the mean epicentral distance between
successive earthquakes over the entire area is $\Delta r = 196$ km. Accordingly,
$\Delta r_{cr} < 196$ km/5 = 39 km, where Δr_{cr} is the critical distance to which
an earthquake with $K > 10$ can be combined into groups. The distance 39 km
is the conditional limiting radius of influence of earthquakes on one
another for classes $K > 10$; Δr_{cr} is the critical distance between earth-
quakes close in time, when they can be combined into groups. The critical
time between successive earthquakes, when they can be combined into groups,
is 20 days. In actuality, the overwhelming number of group earthquakes
with $K > 10$ occur even at distances considerably less than 40 km and in
time intervals considerably less than 20 days. The gradual exclusion of
earthquakes of lower energies makes it possible to evaluate the difference
in the nature of grouping of earthquakes of different intensity. Large
groups are usually associated with strong earthquakes. In Tadzhikistan
65% of the total number of earthquakes with $K > 10$ are group earthquakes
and only 35% are isolated. It is shown that the method described in this
paper makes it possible to discriminate interdependent events with a high
degree of reliability: more than 95% for groups of two earthquakes and
not less than 98% for groups of three or more earthquakes. Figures 4,
tables 3; references: 9 Russian.
[325-5303]

PROSPECTS FOR PETROLEUM AND GAS IN DNEPR-DONETS DEPRESSION

[Article by P. F. Shpak and V. G. Dem'yaruhuk, Geology Ministry Ukrainian
Academy of Sciences, "On the Problem of the Prospects for Finding Pet-
roleum and Gas in Deeply Buried Complexes of the Lower Carboniferous in
the Dnepr-Donets Depression"]

[Abstract] About 100 petroleum and gas deposits have now been discovered
in the Dnepr-Donets depression. The principal productive complexes are
Lower Carboniferous, Lower Permian-Upper Carboniferous and Middle Carbon-
iferous. The first two contain about 95% of the explored and 85% of the
predicted reserves. The Lower Carboniferous deposits contain 72 deposits
containing more than 70% of the predicted reserves of hydrocarbons. A map
in the text shows the distribution of new zones of petroleum and gas ac-
cumulation in Lower Carboniferous deposits. Newly collected data indicate
that deeply buried complexes of Tournaisian, Visean and Serpukhovo age are
characterized by relatively satisfactory capacity and filtration properties
capable of accumulating commercial accumulations of hydrocarbons. This
means that there should be a broadening of regional and exploration work
in the mentioned complexes in the Kotelevsko-Belousovskaya, Glinsko-Roz-
byshevskaya, Solokhovsko-Matveyevskaya, Yablunovsko-Koshevoyskaya, Semen-
tsovsko-Abazovskaya, Bogatoysko-Shandrovskaya and other tectonic zones,

and also the Bel'skaya deep structure. Another extremely promising direction in regional and geological exploration work is study of the deep structure, petrophysical characteristics and petroleum and gas content of Carboniferous deposits in depression zones of the Dnepr-Donets basin. For studying these deep structures it is necessary to increase seismic investigations by progressive methods of longitudinal-nonlongitudinal profiling and the "broad" profile method. There is also a need for increasing the volumes of multivariant processing of geophysical information. The speed of drilling of deep boreholes must be increased by a factor of 1.5-2 and there must be a substantial reduction in the time spent on borehole testing. Figures 1.
[332-5303]

DRILLING OF DEEP YUZHNO-AKHTYRSKAYA BOREHOLE

[Article by V. B. Porfir'yev, V. B. Sollogub, A. V. Chekunov, V. A. Krayushkin, M. I. Ponomarenko, V. P. Klochko, V. M. Girich and M. M. Lushpey, Institute of Geological Sciences Ukrainian Academy of Sciences, Geophysical Institute Ukrainian Academy of Sciences, UkrGIPRONIIneft' Trust and Kiev Geological Specialized Party of the "Ukrneft'" Combine, "Geological Validation for the Yuzhno-Akhtyrskaya Parametric Borehole in the Dnepr-Donets Petroleum- and Gas-Producing Province"]

[Abstract] Academician Ukrainian Academy of Sciences V. B. Porfir'yev and his colleagues have scientifically validated a fundamentally new object for petroleum exploration in the Ukraine -- the fissured basement rocks in zones of deep faults. They have proposed the drilling of the Yuzhno-Akhtyrskaya parametric borehole in the Dnepr-Donets basin (Fig. 1 in the text pinpoints the site and shows a cross section of the structure). The planned depth of this borehole is 8,000 m. It should penetrate into the pre-Paleozoic rocks in the Dnepr graben. Porfir'yev is an adherent to the hypothesis of an inorganic genesis of petroleum and gas. It is postulated that the formation of the latter in sedimentary, metamorphic and crystalline complexes of any geological age and in all petroleum regions on the earth occurred as a result of the vertical ascending migration of petroleum fluids along fault zones from the upper mantle. The possibility of discovering very large petroleum deposits in basement rocks, in any case, is indisputable. As a result of deep drilling petroleum and gas shows have been found in crystalline basement rocks in a number of areas in the Ukraine. The Yuzhno-Akhtyrskaya borehole will make it possible: 1) to investigate the deep structure of the central part of the Dnepr-Donets basin and evaluate the prospects for petroleum and gas in pre-Devonian formations, and also deposits of the Devonian and Lower Carboniferous; 2) to study the hydrogeological and thermopressure characteristics of the section and also the patterns

of distribution of sedimentary rocks-collectors in the depth range 5.0-6.5 km; 3) for the first time in the basin drill to and study cores from the zone of the distinct seismic discontinuity detected by seismic exploration at a depth of 6.5-7.0 km and identified either with the top of the Riphean (Lower Paleozoic) rock complex or with the surface of the pre-Riphean basement, which is important for solving the problem of the true geological nature and stratification of this discontinuity; 4) for the first time investigate the peculiarities of structure and petroleum and gas prospects of the section in the depth range 7.0-8.0 km in the zone of a deep fault separating the primarily gas- and primarily petroleum-bearing regions of the Dnepr-Donets basin. Figures 2.

[332-5303]

ALGORITHMIC METHODS FOR PREDICTING DNEPR-DONETS PETROLEUM AND GAS

[Article by B. P. Kabyshev, A. F. Shevchenko, D. I. Chuprynin and A. G. Ivashkin, Chernigov Division, Ukrainian Scientific Research Geological Prospecting Institute, "Prediction of Petroleum and Gas Content of Local Structures in the Dnepr-Donets Depression in Lower Carboniferous Deposits by Algorithmic Methods"]

[Abstract] The authors give the results of prediction of the petroleum and gas content of local structures in the Dnepr-Donets depression. The investigations were made for a new group of structures with the use of a revised set of criteria and with use of new recognition algorithms. The purpose of the work was a further improvement in prediction of petroleum and gas content of local structures prepared for exploratory drilling. The investigation involved use of the following 13 predictive or informative criteria: paleodepth of the productive complex by the beginning of the Upper Permian; elasticity of water-dissolved gases; metamorphism of ground water; content of hydrocarbons in water-dissolved gases; paleointensity of structure; increase in amplitude in Paleozoic; paleoamplitude of structure; depth of bottom of Upper Permian; sulfate content of water; depth of top of basement; thickness of productive stratum; temperature at top of productive complex; paleodepth of bottom of Upper Visean before beginning of Early Visean. In order to increase the reliability of the forecast, in the classification of structures use was made of three tested methods: 1) discriminant analysis, 2) recognition on the basis of "distance", 3) recognition on the basis of "angle." Three tests were applied for assigning the classified (predicted) structure to the productive or nonproductive classes: 1. The structure is predicted to be productive if it is so evaluated on the basis of all three or two (any of the three) methods. 2. The structure is predicted to be nonproductive if it receives such an evaluation on the basis of all three methods. 3. The prediction is uncertain if the structure is evaluated as unproductive by two methods (any of the three) and by the third

method is evaluated as productive. A classification of a large number of
structures not evaluated by drilling is given in Table 2. This classific-
ation makes it possible to proceed with exploratory drilling of those
structures which are predicted to be productive, with lesser priority also
proceeding to exploratory drilling of structures with an uncertain predic-
tion, and postpone (until new encouraging data are obtained) drilling of
those structures which are deemed to be nonproductive. Tables 4; refer-
ences: 5 Russian.
[332-5303]

THEORY OF ORIGIN OF TSUNAMIGENIC EARTHQUAKES

[Article by L. I. Lobkovskiy and O. G. Sorokhtin, Institute of Oceanology,
"Tectonics of Lithospheric Plates and Origin of Tsunamigenic Earthquakes"]

[Abstract] The problem of genesis of coastal earthquakes responsible for
tsunamis is highly important for an understanding of geotectonic process-
es transpiring in active transition zones between the ocean and the con-
tinents. The accumulated data on tsunamigenic earthquakes can be tied in
to a mechanical model of thrusting of oceanic lithospheric plates beneath
the island arcs and active continental margins. The basis for the model is
the assumption of elastico-plastic behavior of the lithosphere at geolog-
ical time scales, following logically from the concepts of the theory of
lithospheric plates and confirmed by modern geological-geophysical data.
The underthrusting model leads to important conclusions concerning the na-
ture of distribution of seismicity, the most predominant directions of dis-
locations and faults at the foci of earthquakes occurring under oceanic
slopes of the island arcs. A linear zone of plastic deformations sloping in
the direction of the ocean should be manifested seismically in the form of
a focal surface dipping under the ocean to a depth of about the thickness
of the lithosphere ($\sim$100 km). The hypocenters of tsunamigenic earthquakes
in actuality should lie on the conjugate focal surface dipping under the
ocean. (A somewhat different mechanism is responsible for the appearance
of tsunamigenic earthquakes at shallow depths.) The mechanical model dis-
cussed in this paper makes it possible to understand the principal patterns
of manifestation of seismicity under the slopes of island arcs and in par-
ticular, explain the characteristic features of the focal mechanism of
tsunamigenic earthquakes. Figures 2; references 12: 9 Russian, 3 Western.
[320-5303]

PETROPHYSICAL METHODS IN PETROLEUM AND GAS EXPLORATION

[Article by H. I. Petkevych, "Petrophysical Studies Connected With Reconnaissance and Exploration of Petroleum and Gas Deposits"]

[Abstract] Petrophysics is the study of the physical properties of rocks, combining their geological, geophysical and physical aspects. Petrophysical data are widely used in exploratory and industrial geophysics, geological mapping and in mining. Among a number of narrow-interest studies, petroindustrial petrophysics occupies a leading place in connection with the search for new oil and gas fields. A spectrum of studies was supported by the Institute of Geology and Geochemistry of Combustible Minerals. These investigations were directed to the development of a geophysical diagnosis of productive strata. The studies included the formulation of a priori petrophysical models, experimental modeling of synthetic rocks and analysis of petrophysical relationships, leading to the practical application of these data in the search for and exploitation of petroleum and gas deposits. Improvements in the theory and methodology of petrophysics should lead to increased effectiveness in the search for new deposits and the calculation of available reserves. References: 14 Russian.
[282-7813]

PRINCIPLES FOR ELECTROMAGNETIC EXPLORATION AT SEA

[Article by V. I. Hordiyenko, "Construction Principles for Electromagnetic Exploration at Sea"]

[Abstract] Four principles for the construction of equipment for electromagnetic exploration at sea are cited in this review: 1) Preservation of the propagation characteristics of the excitation frequency of an artificial electromagnetic field source requires that the system not be affected by the dynamics of the sea medium, 2) In order to ensure a high efficiency of electromagnetic exploration at sea the spaced electrodes must be used as excitation sources, 3) The vector components of the intensity of electric or magnetic fields should be determined by two field detectors located on a straight line, a certain distance apart, connected in series, 4) The locations of all the elements in the electromagnetic exploration system and their spatial orientation should ensure optimum accuracy of the readings and a maximum depth. Figures 5; references 21: 18 Russian, 3 Western.
[282-7813]

SEISMOTECTONIC DEFORMATION OF PETER I RANGE

[Article by A. A. Lukk and S. L. Yunga, Institute of Physics of the Earth, "Detailed Investigation of Seismotectonic Deformation of Peter I Range"]

[Abstract] The peculiarities of the focal mechanisms of weak earthquakes ($M < 4$) in the central part of the Garm region (Peter I Range) are examined. The general course of seismotectonic deformation in Peter I Range is examined in detail. The correspondence coefficient k^α is used in comparing each focal mechanism and deformations within the range. Sectors with low mean values of the correspondence coefficient and simultaneously with a high seismicity level are interpreted as zones of increased microfissuring of the earth's crust. In these zones there are earthquakes with a nonquadratic distribution of the signs of the first arrivals of P-waves. This effect is interpreted as a manifestation of complex shears without separation at the foci of such earthquakes. Figures 5, Tables 2; references 17: 13 Russian, 4 Western.
[322-5303]

SELF-TEACHING SYSTEM FOR INTERPRETATION OF GEOPHYSICAL FIELDS

[Article by V. N. Nikolenko, Geophysical Institute imeni S. I. Subbotin, Ukrainian Academy of Sciences, "Construction of a Self-Teaching System for the Complex Interpretation of Geophysical Fields for the Recognition of Geological Features"]

[Abstract] The problems involved in applicability of self-teaching systems for classification in geology and geophysics are investigated. The author examines two grouping algorithms with self-teaching. The block diagram of an automated system for the classification and prediction of geological features is examined in detail. The method employed and the results of its use in the presence and absence of standard data are described. The recognition system described here was tested for use in geological mapping and the prediction of minerals and also in the description of petroleum-bearing strata in teaching and self-teaching regimes. The method is particularly effective in solving diagnostic problems in geologically complex regions. The method gives a substantial increase in the information yield of geophysical (especially gravimagnetic) data. The method is adaptable to use of a broad complex of geological-geophysical data. Figures 4; references: 12 Russian.
[322-5303]

METHOD FOR DISCRIMINATING PRECURSORS OF MEDIUM-INTENSITY EARTHQUAKES

[Article by T. V. Guseva, I. L. Nersesov and Yu. P. Skovorodkin, Institute of Physics of the Earth, "Discrimination of Precursors of Medium-Intensity Earthquakes by Magnetometric and Geodetic Methods"]

[Abstract] Geodetic and magnetometric observation systems make it possible to obtain information on deformation processes and changes in the fields of stresses responsible for tectonic earthquakes and compare them in time. Repeated determinations of relative vertical movements of the earth's surface ΔH are used in characterizing deformation processes. The index of change in the stressed state of rocks is the temporal change in the modulus of the local geomagnetic field total vector ΔT. Investigations of ΔH and ΔT should be concentrated in "indicator" sectors of seismogenic regions, such as faults and contiguous geostructures of the transition zone from the Pamirs to the Tien Shan, where the Garm polygon is situated. There since 1969 specialists have carried out more than 80 cycles of ΔH measurements at individual points and during the period 1974-1978 made about 5,000 repeated ΔT determinations over an area of about 5,000 km^2. These observations indicated that there are quasiperiodic anomalous changes ΔH and ΔT of different duration. The rather clear anomalous changes ΔH_a and ΔT_a reflect different processes characteristic of zones of present-day orogenesis, making it difficult to discriminate anomalous changes associated with the seismotectonic cycle and this leads to "false alarms." The fundamental task in the predicting of earthquakes is therefore the recognition of an earthquake precursor as such. Analysis of ΔH and ΔT time series makes it possible to discriminate anomalous changes preceding local earthquakes with hypocenters at a depth of 0.15 km. In 70% of the cases ΔT_a were discovered before earthquakes with $3.3 \leqslant M \leqslant 5.0$ at a distance from 3-5 to 50-60 km from an epicenter. However, local earthquakes with these magnitudes are observed which are not preceded by significant changes in ΔH and ΔT. From cases of a reliably established correspondence between anomalous changes ΔT_a (8 cases), ΔH_a (7 cases) and local earthquakes with $3.3 \leqslant M \leqslant 5.6$ it was possible to derive an empirical dependence of the duration Δt_a of field changes preceding a tremor on earthquake magnitude

$$lg\Delta t_a = 0.84 - 1.85$$

with a correlation coefficient $r = 0.90$; $\delta = \pm 0.13 \, lg\Delta t_a$, where Δt_a is measured in days. Separately for ΔT_a and ΔH_a the dependence of Δt_a on M has the form

$$lg\Delta t_a = 0.73M - 1.58, \quad r = 0.98;$$
$$lg\Delta t_a = 0.59M - 0.53, \quad r = 0.85.$$

Figures 2; references 4: 3 Russian, 1 Western.
[311-5303]

HORIZONTAL TORSION BALANCE AS SEISMIC FIELD SENSOR

[Article by V. M. Popov, Institute of Physics of the Earth, "Horizontal Torsion Balance as a Seismic Field Sensor"]

[Abstract] At present horizontal torsion balances, employed for such purposes as elements of the gravity field, are not used for measuring seismic signals (translational accelerations of the base). This is attributable primarily to the fact that such accelerations act directly only on the pendulum degrees of freedom of the torsion system, not creating a torque on the symmetric arm. However, with a more thorough study of the torsion balance it can be noted that there are relationships between the torsional and pendulum degrees of freedom, ensuring a sensitivity of the torsion balance to seismic effects. The pendulum oscillations which develop are transformed in accordance with the structure of the nonlinear relationships and create perturbations acting on torsional motion. In this paper it is demonstrated that for some seismic signals, by making use of these properties of the nonlinear relationships, it is possible to create a sensor of seismic signals of optimum sensitivity on the basis of a torsion balance. The modulation of such a seismic signal, acting on the torsion balance, characterizes the change either of the properties of the radiation source or the properties of the medium in which the signal is propagated (in this case the earth). References: 7 Russian.
[320-5303]

PHYSICS OF ATMOSPHERE

SPECIAL ANTENNA FOR INVESTIGATING IONOSPHERE FROM SHIPBOARD

[Article by Yu. A. Afinogenov, G. V. Vasil'yev and V. A. Garbatsevich, "Delta Antenna With Upper Feed Having a Coaxial Feeder for Investigating Ionospheric Parameters Under Shipboard Conditions"]

[Abstract] Rhombic or semirhombic (delta) antennas are usually used at ionospheric stations for vertical sounding and absorption measurements. In scientific investigations at sea the use of such antennas involves difficulties in deployment and attachment to the ship and in ensuring safety for the crew and deck mechanisms such as cranes and winches. During the study of latitudinal variations of ionospheric parameters on the 20th voyage of the "Akademik Korolev" specialists developed a modified delta antenna with upper feed through a coaxial feeder and without horizontal "arms," which virtually do not emit due to the closeness of the ship's hull. Two wires were drawn into each "arm" for evening-out antenna wave resistance in a broad frequency band. The antenna "arms" were made in the form of two leads diverging by 2 m at the base. A load resistance of 600 cm was divided into two 300-cm resistances cut in between the base and the ship's hull. Processing of the results of the scientific experiment revealed the effectiveness of the employed antenna-feeder system for registry of ionograms by the vertical sounding method and measurement of radio wave absorption. Despite the small geometrical dimensions of the antenna and its simplicity, the results show that it operates well in the entire range from 1 to 15 MHz. References: 1 Russian.
[312-5303]

OBSERVATIONS OF ARTIFICIAL LUMINESCFNCE OF IONOSPHERE

[Article by G. G. Managadze, T. G. Adeyshvili, N. A. Leonov, A. D. Mayorov and A. A. Martinson, Abastumani Astrophysical Observatory, Georgian Academy of Sciences, "On-Board Measurements of Artificial Luminescence in the Ionosphere Under the Influence of an Electron Beam"]

[Abstract] The article describes artificial modification of the ionosphere by electron beams of different energies from a high-altitude rocket in the "Stereotop" experiment of 1 December 1978 carried out near Volgograd using an MR-12 meteorological rocket lifting the instrument payload to an altitude of about 145 km. The rocket carried a new type of electron accelerator. A diode electron gun with a lanthanum hexaboride cathode injected electrons perpendicular to the longitudinal axis of the rocket. The gun operated beginning with the 190th sec of flight in a pulsed regime: 0.6 sec — injection, 6 sec -- pause. The energy of the accelerated electrons was 3-5 KeV, current strength was 0.1-0.2 A and the angle of beam divergence is $\sim 7.5°$. Measurements of luminescence of the ionosphere arising under the influence of the electron beam were made with a modulation photometer. The volume of the region intersected by the beam was $\sim 10^4$ cm^3. The photometer could simultaneously register a spectral line and background luminescence, separating them in two telemetric channels. The luminescence of the green line λ = 5577 A above the background, associated with beam injection, was registered by the photometer on the descending segment of the trajectory beginning at an altitude of about 140 km. Below this altitude the photometer registered an increase in the glow of λ = 5577 A for each of 13 injection pulses. For altitudes of 140 km or more the intensity of the generated radiation was beyond the instrument response threshold. The processing of telemetric data revealed that the intensity of the registered radiation changed with altitude. The article describes these changes and the authors discuss the mechanisms probably responsible for the observed variations in the altitude range 95-140 km. Figures 1; references 9: 5 Russian, 4 Western.
[302-5303]

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